# 8 HUMAN FACTORS

The human component of the NAS is a key element of NAS modernization. Focusing on human factors elements of new systems early in the acquisition process reduces costs, minimizes program schedule disruptions, and brings new benefits to NAS users earlier.

## 8.1 Human Factors Activities—NAS-Wide

A broad range of activities regarding the implications of human factors will be conducted to support NAS modernization. These activities involve both acquiring and applying the information necessary to capitalize on human capabilities and limitations that affect human-system performance in each domain. Human factors engineering research and application activities will be employed to identify and resolve risks and to assess costs, benefits, performance levels, and tradeoffs. Issues for which human factors research and application activities will be employed include:

- Computer-human interface (CHI)
- Controls, displays, and alerts
- Procedures, incremental changes to systems, and system component integration
- Workforce productivity, workload, usability, and task performance
- Training for new automation operation and maintenance; equipment, workspace, and workplace design
- Manpower resources and staffing; unique skills, abilities, characteristics, and tools; communications and teamwork; job and organizational design
- Human performance aspects of safety, health, and environmental considerations.

Through these activities, human factors will be systematically integrated into every phase of NAS modernization. While the range of endeavors undertaken to integrate human factors in the NAS is necessarily broad, six major activities are listed and described below:

- Life-Cycle Costs, Benefits, and Tradeoffs
- Human Performance Metrics and Baselines
- Consistent Computer-Human Interface Prototypes
- Human-in-the-Loop Simulations
- Task Analysis and Workload Measurement
- Workstation Integration.

In addition to its own efforts, the FAA will work with the National Aeronautics and Space Administration (NASA), the Department of Defense (DOD), and others to take advantage of their human factors research.

## 8.2 Life-Cycle Costs, Benefits, and Tradeoffs

Research (and the application of the results) is needed for more information on the costs, benefits, performance levels, and tradeoffs of alternative approaches to meeting NAS requirements. This activity will develop and apply sources of data and help integrate a human performance perspective into investment analysis and programmatic decisions. The activity will provide human factors information to conduct the necessary alternatives evaluations, assess current and future affordability, contribute to the tradeoff analyses and investment decisions, and resolve cost-effectiveness issues during solution implementation. Results of this activity include:

- Identification and description of human factors variables that impact costs, benefits, and tradeoffs (e.g., the types of operational benefits related to human performance on new and upgraded systems)
- Methods to predict and assess the relevant human factors variables and risks that significantly impact system performance (e.g., how to identify the risks of operator cognitive workload for critical functions/tasks in en route, terminal, traffic management, and oceanic domains)
- Algorithms to quantify human factors variables and their relationships (e.g., human-system performance cost-benefit estimating relationships for new display concepts)
- Information related to human factors costs, benefits, and tradeoffs (e.g., establishing the means to assess systems using historical and

evolving records, such as data on task analyses and training for deployed systems)

- Assessments of the tradeoffs associated with human factors, including personnel selection, staffing, training, and human-system performance.

### 8.3 Human Performance Metrics and Baselines

As new systems are acquired to replace or augment those currently deployed, human performance metrics and baselines will be developed. These metrics will be used to quantify current operational efficiency and effectiveness, facilitate market survey analysis, assess progress during system development and implementation, and support system performance tests and evaluation. Results of this activity include:

- Metrics to assess human and human-system performance (e.g., standardized metrics and measurement techniques for assessing operator/maintainer workload, staffing, and training for vendor solutions during market surveys)
- Methods to benchmark human-system performance, usability, and suitability (e.g., development and application of techniques, tools, and procedures for determining and mitigating potentially high levels of individual and team communication requirements)
- Ways to link varying levels of human performance to operational system capabilities (e.g., the measures of workload related to the maturity of a system's technology and CHI)
- Development of a comprehensive set of scenarios, system configurations, environmental measures, and simulation concepts for conducting baseline and subsequent assessments (e.g., operational scenarios for terminal operations to evaluate procedural changes)
- Baseline assessments and periodic measurements of NAS systems using human-system performance metrics.

### 8.4 Consistent Computer-Human Interface Prototypes

Studies have shown that the final cost of software and hardware depends largely on changes to the initial system design. Also, a disproportionate share of system changes are a result of human-system integration and CHI requirements. Without well-planned human-system integration, acquired NAS systems that employ commercially available solutions could result in increased software cost, higher training time, and greater operational complexity. Safety and productivity in the NAS will be enhanced through the development of common interfaces, consistent CHI, and compatible functions and procedures. Results of this activity include:

- Concepts and prototypes for compatible preplanned product improvements (e.g., compatible CHI for terminal and en route upgrades)
- Common CHI designs for systems migrating to common platforms and consoles (e.g., common function and form interfaces for systems transitioning into the NAS)
- Tools, techniques, and capabilities to rapidly prototype new CHI designs, assess vendor CHI solutions, and evaluate the impact of CHI alternatives (e.g., assess the strengths and weaknesses of new CHI designs and specifications for NAS applications)
- Technical standards and specifications for future CHI manufacturing designs (e.g., common core functions, display characteristics, and operational procedures for new Global Positioning System (GPS) receivers)
- Configuration management capabilities to compare CHI compatibility between system components and to design new systems' CHI.

### 8.5 Human-in-the-Loop Simulations

A method for scientifically predicting how a human would react and perform under certain conditions when operating or maintaining a new system is referred to as a "human-in-the-loop" simulation. Human-in-the-loop simulations of developing systems allow human-performance characteristics to be systematically analyzed and evaluated. Task loading and sequencing, information processing, and crew coordination need to be examined to identify and resolve potential risks and opportunities. Examining these areas will also provide an early indication of whether human performance associated with a system will support NAS

performance requirements. Primary results of this activity include:

- Mission scenarios (developed for various domains, with sufficient fidelity to ensure objective, quantifiable measures) that will allow examination of controller and pilot performance in a realistic environment
- Simulation results/findings that verify critical tasks, validate task analyses, refine procedure designs, assess training regimen designs, and identify implied operation and maintenance diagnostic and problem-solving activities
- Comprehensive and consistent assessments and measurement of human performance within systems and across the integration of systems.

### 8.6 Task Analysis and Workload Measurement

Much of the work associated with task analyses and workload measurement is focused on "time required" versus "time available" for operator and maintainer performance. The measures of time and accuracy (e.g., error rate) will be used with other measures to assess and improve human-system performance. These measures will supplement subjective rating scales that provide insights into user attitudes, but do not always correlate with objective measures of performance. Primary results of this activity include:

- Validated tools and techniques, both objective and subjective, to provide measures of the cognitive task and workload assigned to operators and maintainers
- Data bases to support development of task analyses and workload measurements
- Resulting analyses and measurements that describe human-system performance at the required component level of the system.

### 8.7 Workstation Integration

Human factors activities related to workstation planning, analysis, and implementation will ensure that the design of the workstation is suitable for its intended application and use by the system operator and maintainer. Primary results of this activity include:

- Methods to describe and control the design of complex workstation configurations
- Design guidelines for systematic integration of a variety of control and display devices to enhance operator and maintainer performance
- Design and implementation analyses, alternatives, and recommendations for configuring future workstations and NAS workstation environments.

### 8.8 Summary

These human factors activities provide a framework for developing and implementing human-system performance advances in the NAS. It is important to recognize that the description of these activities represents only an outline of the necessary steps toward achieving the NAS human factors objectives. While the description of the human factors work in support of NAS development may be categorized into broad, generic areas and activities, the work that is performed must be tailored to the specific systems and issues to be addressed in each domain. Detailed human factors research and application efforts within each domain are required to institutionalize the consideration and resolution of human performance issues and reduce many of the operationally significant human performance challenges facing the nation's aviation system. An overview of the work to be accomplished in each domain is discussed in the domain writeup.